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AERIAL SURVEYS FOR BREEDING WATERFOWL, ATLANTIC REGION, 1985-1989

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Abstract

With continuing concern over declines in numbers of Black Ducks (Anas rubripes), efforts to monitor breeding populations of this species were renewed in the Atlantic Provinces, beginning in 1983. Helicopter surveys in spring were begun in New Brunswick in 1985, and extended to Nova Scotia and the island of Newfoundland in 1986. These pilot projects were proposed to continue for 5 years (through 1990). Observed breeding densities were highest in N.B. and lowest in Nfld., presumably reflecting a temperate to boreal/subarctic trend. Densities increased each year in N.B. but less consistently in the other provinces. The apparent increases may reflect general recovery of populations following harvest restrictions in the U.S.A. since 1982, but the trends are not (yet) conclusive.

Resume

En raison de la preoccupation constante au sujet du declin de la population de Canards noirs (Anas rubripes), les efforts en vue de surveiller les populations reproductrices de cette espece ont repris dans les provinces de l'Atlantique, depuis 1983. Au printemps de 1985, des leves aeriens en helicoptere ont debute au Nouveau-Brunwsick et ceux-ci se sont propages en Nouvelle-Ecosse et a Terre-Neuve en 1986. Ces projets pilotes devaient se poursuivre pendant cinq ans (jusqu'en 1990). On a observe que la densite de la nidification etait le plus elevee au Nouveau-Brunswick et le moins elevee a Terre-Neuve, ce qui pourrait refleter une tendance a la concentration dans les regions au climat tempere en allant en decroissant dans les regions au climat boreal ou subarctique. La densite de la nidification s'est accrue chaque annee au N.-B., mais l'accroissement a ete moins constant dans les autres provinces. Les augmentations apparentes traduisent peut-etre une reprise des populations a la suite des limites imposees sur la chasse aux Etats-Unis depuis 1982, mais les tendances ne sont pas encore concluantes.

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Introduction

The goal of waterfowl management is to effect changes in numbers of these game birds, as required for their conservation. Effectiveness of management is best assessed by monitoring the changes in numbers of waterfowl that follow - and are assumed to result from - implementation of management practices. Without concurrent monitoring, management of waterfowl populations is more of an art than a science.

Past attempts to establish waterfowl monitoring surveys in the Atlantic Provinces (summarized in Erskine 1987a) foundered on low cost-effectiveness and limited resources. Surveys should allow comparisons from year to year and over longer periods, and between areas. Low densities of breeding waterfowl in the Region led to changing of procedures in attempts to get more information from the limited effort that could be deployed. During the first 12 years (1949-60) of surveys in the Maritimes, no data series was comparable over longer than a 3-year period. Dissatisfaction with these efforts led to the Canadian Wildlife Service (CWS) and United States Fish and Wildlife Service (USFWS) abandoning attempts to monitor breeding waterfowl in the northeast soon after 1960 (cf. Chamberlain and Kaczinski 1965). The Mid-winter Waterfowl Inventory (MWI) and the national harvest surveys (NHS) then remained the only instruments for monitoring numbers of Black Ducks. The MWI and NHS are ongoing operations that provide useful data for various other waterfowl species as well as Black Ducks. However, details of the trend data on Black Ducks arising from the MWI have been questioned by many waterfowl managers. The widely expressed concern over declining numbers of wintering Black Ducks along the eastern seaboard led to the court challenges in the U.S.A. by Grandy (1983) and the Humane Societies of the United States. These, with the emergence of the North American Waterfowl Management Plan (NAWMP), formally signed in 1986, resulted in the recent monitoring efforts sponsored through the Black Duck Joint Venture (BDJV) by Canada and the United States.

The challenges in the U.S.A. argued that inappropriate management of harvest had allowed over-exploitation and reduction of Black Duck populations, and pointed to reduction or elimination of harvest as the immediate remedy. In Canada, provincial management agencies opposed harvest reduction without ongoing surveys to assess the effects of reduced harvest on local breeding populations. BDJV money became available in 1985, when an experimental aerial survey of breeding pairs was initiated in the region, following recommendations in the 1984 review of Black Duck surveys (R. McKelvey, for CWS-HQ, unpubl.).

This paper describes the methods used, and summarizes and discusses the results, to allow more complete understanding of the

evolving techniques. The contributions of the authors were as follows: GRP pioneered the sampling and aerial survey procedures, modified for the McKelvey report from those used in Ontario (Ross, 1985, 1987), and was responsible for surveys in New Brunswick; RIG adapted some aspects of the Quebec survey procedures (Bordage 1988) for use in Newfoundland, where he conducted the surveys; MCB conducted the surveys in Nova Scotia, using the same approach as in New Brunswick except as to timing of surveys. This account was compiled, from annual reports by the other authors, and edited, by AJE, who arbitrated the sometimes conflicting viewpoints of the others. By request, AJE's name appears first; names of the other authors follow in alphabetical order, as their relative contributions were equivalent.

Methods

(a) Prince Edward Island. With the small area and extreme interspersion of coastal and inland habitats in the island province, the monitoring system there employed ground surveys, repeated at intervals through each season. These surveys will be the subject of a separate report (M.C. Bateman, in prep.), and are not discussed further here.

(b) New Brunswick. The approach in N.B. involved a modification of the systematic sampling used in northern Ontario (Ross 1985). To minimize both unproductive survey time and the statistical difficulty with "zero counts" (plots on which no Black Ducks were recorded), the sampling plan involved a random selection of 1:50,000-scale map-sheets, with replacement, with selection of a 5kmx5km plot on each sheet that was judged - from the map - to represent good Black Duck habitat. This approach was considered acceptable for detecting changes in waterfowl populations of 10% or more over a 5-year period, although inappropriate for precise estimation of total populations by extrapolation. The sample in 1985 comprised 25 plots; this was increased to 41 plots in 1986 and later years. Locations of plots are shown in Figure 1.

The plots were positioned on a map of the province, and a route was established to allow a total search of each plot with a minimum of ferrying time. Surveys were conducted using helicopters (Bell 206B Jet Ranger), flying at 15-30m above water/ground level at speeds from 150km/h down to a hover, as required for thorough searching. The pilot and navigator-observer sat in front, with two primary observers in the rear seats (in 1986 only one additional observer - on the other side of the aircraft from the navigator). The navigator guided the pilot to the plot, directed the manoeuvering around the plot to sample all bodies of water, and communicated with the observer(s) regarding positions and identity

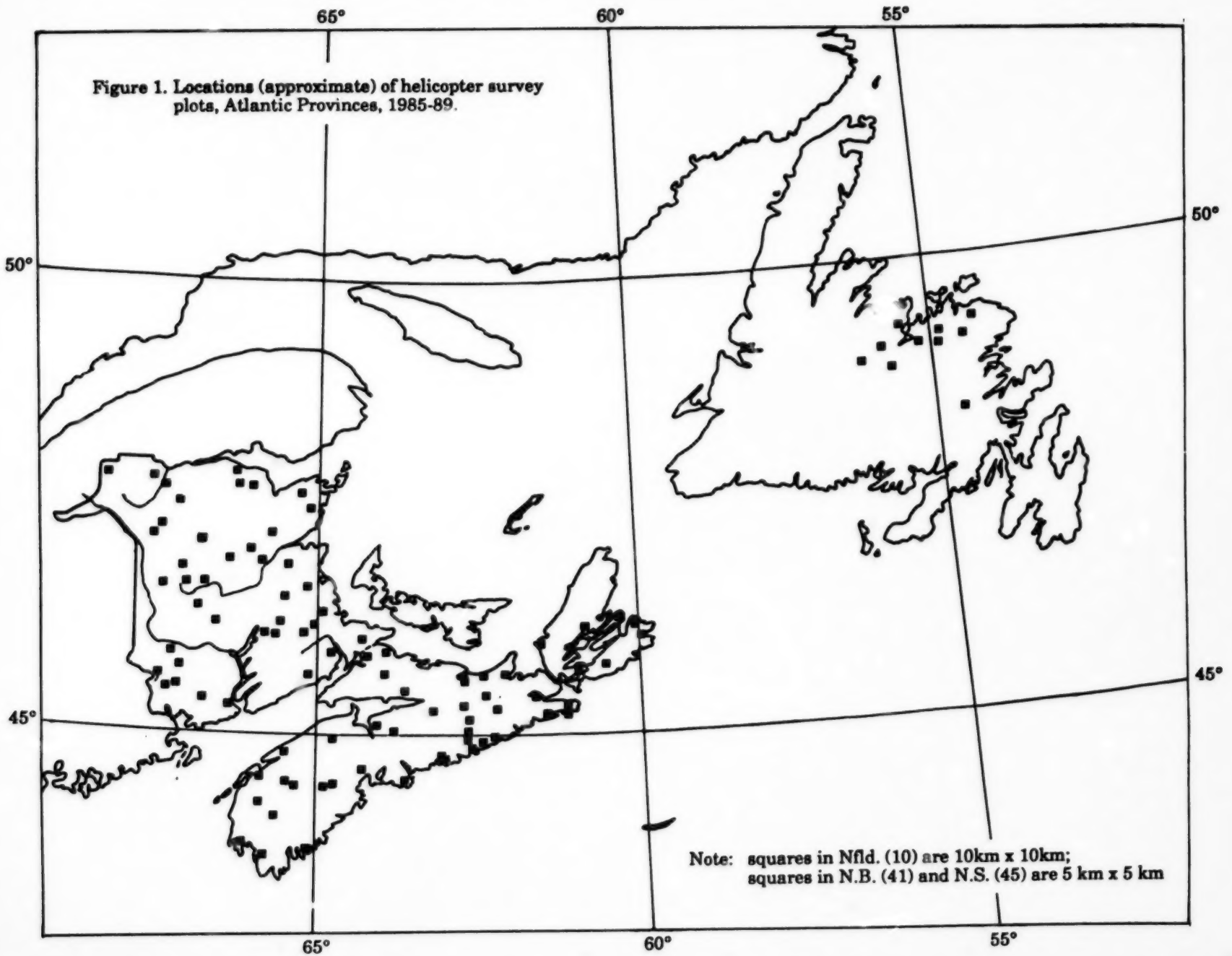

Figure 1. Locations (approximate) of helicopter survey plots, Atlantic Provinces, 1985-89.

of birds. GRP was the navigator-observer, and all observers were CWS personnel in 1985 and 1986; New Brunswick Department of Natural Resources and Energy provided one observer in 1987-89. The navigator entered all data directly on 1:50,000 map sheets as they were reported over the cabin intercom system (this was possible because of low densities of waterfowl).

The surveys were done in early May so as to include the maximum proportion of Black Ducks as breeding pairs; usually 40-55% of total groups seen were pairs. This corresponds roughly to the ratios suggested by Dzubin (1969), which have not been verified rigorously in the Atlantic Region. Surveys were conducted without reference to time of day, with up to 9h flying on a given day while weather permitted.

(c) Nova Scotia. The plot selection was carried out as in New Brunswick, using placement to include some wetlands - but not always "good Black Duck habitat" - within randomly selected map-sheets. Forty-five plots (5km x 5km) were selected in 1986 (Figure 1), and one more was added in 1987 for use in the acid rain study. On map-sheets which included coastal marshes, plots were located so as to sample that habitat, which is important for Black Duck production in Nova Scotia. One plot surveyed in 1986-88 was excluded from comparisons (and omitted in 1989). [This plot included part of an extensive impounded marsh that could not be surveyed reproducibly from a helicopter, as with the high duck density it was impossible to avoid counting some birds more than once. Inclusion of data for this plot would bias the results of the overall survey for several species, as the habitat represented there is exceptional in the province.]

Survey procedures involved two observers, one of whom (MCB) doubled as navigator/recorder (as in N.B. in 1986). All observers were CWS personnel, with the same individuals in all years. The timing of surveys was set by back-dating from brood records provided by the Nova Scotia Wildlife Branch; surveys were in the second week of May, averaging about a week later than in N.B.. Surveys were conducted throughout the day while suitable weather persisted, but flying time rarely exceeded 7h in a day.

(d) Newfoundland (island). An initial survey in 1986 involved coverage of 41 plots, each 5kmx5km. Unlike the N.B. and N.S. practice, but as in Quebec, these plots were randomly placed on randomly selected 1:50,000 map-sheets. Plots were selected as lying within the Central Forest Ecoregion, because about half of the island's Black Ducks breed in this boreal area (Goudie 1987); several when surveyed were found to include subarctic barrens habitats and thus belonged in a different ecoregion. In 1986, the survey could not be flown at the planned date as all aircraft were pre-empted by forest-fire control, and coverage 2-3 weeks later

proved unsuitable for monitoring breeding pairs of Black Ducks. These problems minimized use of the 1986 surveys in comparisons, and the survey was re-designed for 1987.

The final design involved 10 plots, each 10kmx10km, as in Quebec, i.e. total area equivalent to 40 plots of 5kmx5km. These plots were a random subset of those selected before (excluding subarctic plots); all plots (Figure 1) were in the Central Forest Ecoregion. Surveys involved two observers, one of whom (RIG) doubled as navigator/recorder. Timing of the surveys (except 1986) corresponded to those in Nova Scotia, i.e. second week of May. Surveys were mostly restricted to morning (06:00-12:00) and evening (17:30-21:20) hours, when the potential for detection is greater and wind less. This kept survey time per day down to 6h, but extended coverage over a 4-5 day period.

(e) Labrador. Plot surveys by helicopter of waterfowl habitats in the Lake Plateau of Labrador were established in 1970 (Gillespie and Wetmore 1974) and repeated in 1980 (Goudie and Whitman 1987). The plot selection was stratified and systematic, and survey procedures differed somewhat from those in the later surveys. The Labrador surveys paralleled the intensity and reliability achieved elsewhere in the Atlantic Region. The results have been published and are not repeated in this report.

All waterfowl observed were recorded by species, number, and age/sex class (when possible), but for comparison we present all data as Indicated pairs (for Black Ducks only) or Total birds. Total birds are direct totals of all individuals of a species, regardless of category. Indicated pairs include all observed pairs (adult male and female together), and all lone (adult) males and females (after Dzubin 1969). In Black Ducks, many lone birds seen in flight or at a distance cannot be sexed, and such birds were also counted as Indicated pairs. The inclusion of other groupings as equivalent to pairs varied in other studies; some workers included each group of 3, 4, or 5 birds as an Indicated pair (see Dzubin 1969), whereas others did this only for some species or not at all. For consistency and comparison, in this paper we counted only pairs and singles of Black Ducks as Indicated pairs, although treatment in the original reports varied. Thus, our density estimates are probably conservative.

Results

(a) Numbers of waterfowl, by species, year, and area.

The relative numbers of major waterfowl species, expressed as Total ducks/100sq.km., are compared in Table 1, with Indicated pairs/100sq.km. for Black Ducks. Data for less common species are in an Appendix. The larger mergansers were not always identified to species in N.S. Other birds recorded on the surveys are not reported here, except that Common Loon data are given in the Appendix.

Black Ducks were a major species in all three provinces, but ranked second behind Ring-necked Ducks in overall density except in N.B. in 1987-89. Other species were much scarcer. The relative species composition was quite similar in all three provinces, although the total density decreased from N.B. to N.S. to Nfld. The most obvious departures from the pattern were that Blue-winged Teals were lacking in Nfld., and Common Mergansers were relatively more abundant in N.B. and scarcer in Nfld..

(b) Group sizes of Black Ducks.

Data on group sizes provide a rough index to the relative phenology of surveys in different years (Table 2). The 1985 survey in N.B. and the 1986 survey in Nfld. were inappropriately timed, and are included only for completeness.

In N.B., over 50% of the groups observed in 1986, 1988 and 1989 were pairs, but the proportions were lower in other years and areas. In N.B. and Nfld., pairs and single birds combined made up over 90% of the groups observed (except N.B. in 1987). Larger groups were somewhat more frequent in N.S., possibly because of the coastal (staging) habitats included in the survey areas there. The presence of broods, on the 1985 survey in N.B., the 1986 survey in Nfld. and in the eastern section of N.S. in 1986 and 1988, demonstrated the variability in timing of early breeding of Black Ducks.

(c) Year-to-year changes in Black Ducks.

The comparable Black Duck data in Table 1 (4 years for N.B. and N.S., 3 years for Nfld.) span inadequate periods to provide meaningful trends. However, this presentation allows comparisons with surveys elsewhere in the Black Duck's range (Ross 1987; Bordage 1988). Comparisons for other species might be attempted if longer series become available.

The N.B. data showed increases each year, the overall increase (from 1986) amounting to 44% both in Total ducks and in Indicated pairs. The changes from 1986 to 1987 and from 1988 to 1989 were

Table 1. Densities of major waterfowl species seen on aerial surveys, Atlantic Provinces, 1985-89.

Species	N.B. (Ttl.bds./100km2)					N.S. (Ttl.bds./100km2)				Nfld. (Ttl.bds./100km2)			
	1985 (25)@	1986 (41)	1987 (41)	1988 (41)	1989 (40)	1986 (44)	1987 (45)	1988 (45)	1989 (45)	1986 (41)	1987 (10)@@	1988 (10)@@	1989 (10)@@
Green-winged Teal	3.8	4.0	8.1	9.7	12.0	2.9	3.4	6.5	2.0	1.0	4.3	3.0	3.5
Black Duck	22.6 (13.9)#	35.6 (19.0)	41.5 (22.0)	45.8 (22.5)	51.2 (27.4)	26.0 (9.0)	24.4 (9.3)	34.3 (12.0)	29.3 (12.3)	4.3 (3.3)	9.5 (6.3)	15.8 (9.9)	13.4 (8.1)
Blue-winged Teal	3.4	3.3	1.5	3.2	1.7	1.8	2.0	0.8	1.3	0	0	0	0
Ring-necked Duck	27.4	38.1	37.6	29.9	33.7	26.1	17.4	21.5	19.5	25.6	49.1	51.2	47.4
Common Goldeneye	1.6	1.6	5.3	2.4	3.1	0.2	0.4	0.6	0.3	1.0	1.9	5.0	4.0
Common Merganser	17.4	17.1	11.1	13.4	22.0	7.6•	4.9•	5.6•	8.5•	0.9	1.5	3.5	4.7
Canada Goose	0	0.2	0.2	0.6	0.8$	0	0.5	0.3	0.5	2.2	0.0	0.0	0.1

@ No. of 5km x 5km plots surveyed.
@@ No. of 10km x 10km plots surveyed.
# Indicated pairs/100km2.
• Combined Dens/100km2 of Common & Red-breasted Mergansers.
$ Not including a flock of 41 birds.

Table 2. Frequency and proportion of different group sizes observed for Black Ducks, aerial surveys, Atlantic Provinces, 1985-89.

Year	Survey Dates	Group Size Frequency (% of total)					Total Groups
		1	2	3	≥4	Others	
New Brunswick							
1985	May 15-16	28 (57)	16 (33)	4 (8)	1 (2)	+ 1 brood	49 (incomplete data)
1986	May 5,6,10	83 (42)	103 (52)	7 (3)	6 (3)		199
1987	May 5,8,9	98 (42)	99 (43)	24 (10)	10 (5)		231
1988	May 4,5,6,7	86 (36)	136 (58)	3 (1)	11 (5)		236
1989	May 5,9,10	109 (39)	149 (53)	11 (4)	10 (4)		279
Nova Scotia							
1986	May 5-6, 14-15,20-21	45 (38)	55 (47)	8 (7)	10 (8)	+ 1 brood	118
1987	May 11,12,13, 14,15	53 (44)	49 (40)	7 (6)	12 (10)		121
1988	May 5,6,7,8, 13,14	69 (43)	66 (41)	13 (8)	14 (9)	+ 1 brood	162
1989	May 4,5,15, 16,17	70 (45)	68 (43)	6 (4)	13 (8)		157
Newfoundland							
1986	June 3,4,5, 6,7	15 (71)	5 (24)	1 (5)	0	+ 5 broods	21
1987	May 12,13,14,	39 (60)	24 (37)	0	2 (3)		65
1988	May 9,10,11, 12,13	54 (55)	41 (41)	1 (1)	3 (3)	+ 1 brood	99
1989	May 8,9,10, 11,12	40 (47)	41 (48)	3 (3)	1 (1)		85

much larger than that from 1987 to 1988; the latter change was not significant, the others doubtfully so. N.S. data showed insignificant increases from 1986 to 1987 and from 1988 to 1989, but a marked increase from 1987 to 1988, giving an overall 37% increase in Indicated pairs (but only 11% in Total ducks). The Nfld. data showed an increase from 1987 to 1988, but declined from 1988 to 1989 (overall ca. 40% increase).

Discussion

This report summarizes the results of experimental surveys. Wider-scale monitoring plans now make it unlikely that longer series will be obtained for the sample areas discussed here, as a new survey design is anticipated. Some evaluation and interpretation of the recent effort may be helpful.

(a) Timing of surveys.

The surveys were planned to monitor breeding Black Duck numbers. Species with similar breeding schedules, including Mallards, Common Goldeneyes, Common Mergansers, and Canada Geese, may be represented in proportion to their breeding numbers. Other species whose breeding schedules are later than those of Black Ducks will be less well monitored by these surveys. Any single survey of waterfowl in spring involves emphasizing some species over others. Here there was a deliberate choice to pursue the best coverage for Black Ducks, rather than seeking to provide acceptable coverage for as many species as possible.

Earlier surveys might include migrants, especially in coastal areas, and not all breeders would have settled. Later surveys would miss pairs of which the females were on nests while males had already departed to pre-moulting assemblies. Difficulties were experienced in judging in advance relative phenology between years.

Group-size data for Black Ducks (Table 2) allow us to recognize, after the fact, the relative phenology of surveys in different years. All surveys were planned to take place at comparable phenological dates; only the 1986 Nfld. survey was not made when planned. The 1986 Nfld. survey was far out of line with the others, and the 1985 N.B. survey and the eastern N.S. survey in 1986 also were late. The other surveys appeared more or less comparable, but even appropriately timed surveys detected a few broods. Factors used in planning the timing of surveys in advance in 1985-89 included the general run of temperatures during April, the melting of snow in the woods and of ice in lakes, the appearance of first new leaves or catkins on deciduous trees, and observations on the progress of Black Duck pairing in the local

area. All of these have some bearing on the timing of surveys, but they lack standardization and reproducibility.

In 1988, GRP (unpubl.) surveyed a sub-sample of 4 plots on 26 April and 16 May in addition to his regular survey on 6 May, to explore variation in pair-to-single ratios as well as changes in Total birds. Numbers of Indicated pairs of Black Ducks changed little between the first two surveys, but declined on the third survey. He concluded that the presence of groups ranging up to over 100 birds, evidently migrants, on the first survey, coupled with the uncertain weather and locally extensive ice cover at that time, made counts in N.B. in late April less easily replicable than surveys in early May. This agreed with the timing already in use in that province.

Geographic variations in phenology also affect the results. In N.B., surveys of the southern and low-elevation areas were scheduled earlier than the northern and higher-elevation plots. GRP compared the frequencies of Black Duck group sizes for southern and northern areas in 1986, and found no significant differences. He recommended that the northern plots be surveyed a few days later, but not beyond the second week of May. The N.S. surveys were also scheduled - by back-dating from brood data - to start in the southwest, with the central and eastern sections surveyed one and two weeks later. In 1986, a brood in the eastern section (on 21 May) indicated that a smaller spread was more appropriate. The N.S. surveys in 1987-89 were completed by 15, 14, and 17 May, respectively (Table 2), but one brood was seen in the eastern section in 1988 (13 May). The "window" for optimum timing of these surveys - to maximize pairs and minimize migrants - is narrow in this area.

(b) Coastal vs. inland comparisons.

The question of whether migrants may be included on spring pair counts in early May was explored further in N.S., where one-third (15) of the plots included coastal wetlands as well as inland areas. Comparisons of data for plots including coastal wetlands with those for plots with only inland wetlands (Table 3) did not suggest a large proportion of migrants there during the surveys. The relative frequency of groups (3 or more birds) was only slightly greater on plots with coastal habitat, and the groups there averaged a little larger, but the samples of larger groups were small (less than 10). Past experience indicated that most migrating Black Ducks were already paired, although travelling in flocks. The mean number of indicated pairs per plot was greater in coastal than inland plots in all years, which could reflect greater productivity/fertility of the coastal vs. most inland habitats in N.S., or that coastal pairs included some migrants.

Table 3. Comparison of Black Duck group sizes observed on aerial surveys in Nova Scotia, 1986-89, in coastal vs. inland survey plots.

Year	Habitat	Frequency of group sizes observed				Total no. groups	% groups >2	% groups ≥4
		1	2	3	≥4			
1986	Coastal	17	28	4	5	54	17	9
	Inland	27	27	4	4	62	13	6
1987	Coastal	15	22	1	7	45	18	16
	Inland	37	27	6	5	75	15	7
1988	Coastal	30	36	7	7	80	18	9
	Inland	39	30	6	7	82	16	9
1989	Coastal	25	44	3	9	81	15	11
	Inland	45	24	3	4	76	9	5

(c) General effectiveness of the surveys.

Apart from concern over timing, and bias introduced by the few plots in intensively managed (manipulated) marshes, the investigators were favourably impressed with these surveys as a means of monitoring Black Duck numbers. The numbers of waterfowl detected generally exceeded prior expectations, which were largely based on unsystematic coverage in the past. The within-year and between-year variability observed were small enough to allow observer confidence in the method, which would have gained statistical strength if continued longer.

The surveys focussed on monitoring Black Ducks. The species composition found on the surveys indicated that Ring-necked Duck is the only other duck widely detected in large numbers. That species breeds on average a month later than the Black Duck, and it has a sex ratio heavily skewed towards males. Erskine (1987b) found, in eastern Nova Scotia, that counts of Ring-necked Duck pairs even in late May greatly exceeded the numbers of broods found subsequently in the same study areas, which suggested that many of the birds present in spring may not breed locally or successfully. Ring-necked Duck data will require different interpretation than data for Black Ducks.

The proportional representation of Green-winged Teals, which regularly ranked second to Black Ducks in Atlantic Region hunting kill (e.g. Dickson 1989), was certainly low on these aerial surveys - albeit higher than on surveys from fixed-wing aircraft. This may vary inconsistently from year to year. Visibility of teals may be somewhat better in Nfld. where marsh vegetation is less extensive and less dense. The trends in observed densities (Table 1) differed between provinces, with increases each year in N.B., pronounced ups and downs in N.S., and little change (after 1986) in Nfld.. All these patterns might be representative, but the results need some checking if we are to use these or similar surveys to monitor this species.

Common Goldeneyes, which formerly ranked third in hunter kill in the Atlantic Region, were seldom detected on the N.B. surveys (in N.S. this species breeds only on Cape Breton Island). Former ground surveys in eastern Nova Scotia (Erskine 1987b) showed that spring pair counts of goldeneyes were always lower than the numbers of broods found on the same areas in the summer. Presumably many broods had hatched elsewhere (probably upriver, in tree cavities along the floodplains), and later moved to the lake or delta marshes which were surveyed. Monitoring of other waterfowl may require more intensive sampling, as we may not be able to tell what is happening to them from data obtained in Black Duck surveys.

Table 4. Spring population estimates for Black Ducks (individuals) in Atlantic Region, compared to earlier values.

Province	Population extrapolations current surveys (years)	Earlier population estimates (from CWS Occas.Paper 60)
New Brunswick	46,700 (1986-89 mean) 1/	49,300
Nova Scotia	16,500 (1986-89 mean)	31,900
Prince Edward Island	5,700 (M.C.Bateman, unpubl.data)	7,600
Newfoundland (island)	10,800 (1987-89, X2 2/) 1/	37,000
Labrador	No new data available (last survey 1980)	32,800
Total Atlantic Region		158,600
cf. Quebec		600,000 3/
Ontario		300,000 3/

1/ N.B. 1985 and Nfld. 1986 results excluded as unrepresentative.
2/ Surveys covered only the Central Forest Ecoregion, which is thought to contain about one-half of the breeding Black Ducks on the island of Newfoundland (R.I.Goudie, unpubl.).
3/ From unpublished data used in compilation of "A Waterfowl Management Plan for Canada, 1981".

(d) Atlantic Region Black Duck numbers.

The sampling design used in N.B. and N.S., with selected plots on randomly chosen map-sheets, is not appropriate for direct estimation of total populations by extrapolation. Such estimates, based on areas selected as including Black Duck habitat, are inflated. This is unlikely to be balanced by incomplete detection of birds present on the plots, although work in Quebec (Bordage 1988) and Labrador (Goudie and Whitman 1987) suggested that one-half or more of the Black Duck pairs may be missed by a single survey using helicopters. However, estimates obtained by direct extrapolation should be of the correct order. Earlier estimates (Erskine 1987c; Goudie 1987) were higher than, but of a similar order to, those extrapolated from recent surveys (Table 4). We are dealing in the Atlantic Region with Black Duck breeding populations of the order of 50,000 pairs. These would be expected to produce fall flights (before harvest) of the order of 250,000 birds. The present surveys thus support the earlier estimates and the perspectives based upon them (Erskine 1987c,d). The Black Duck is an important game bird in the Atlantic Region, and birds reared here contribute importantly to the harvest in New England. Compared to the numbers reared elsewhere (cf. Table 4), the Atlantic Region contribution to total Black Duck numbers is not large.

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Appendix. Other waterfowl (Anatidae) and loons seen on aerial surveys, Atlantic Provinces, 1985-89. The numbers given are birds seen (not densities), grouped as p = pairs, s = lone birds, f = flocked birds (2 or more, except pairs). Species not known to breed in survey area underlined.

New Brunswick

1985: not available.
1986: Wood Duck 2s; Mallard 3p,3s; Hooded Merganser 5p,2s,12f; Ruddy Duck 1s; Common Loon 11p,7s.
1987: Wood Duck 4p,5s,5f; Mallard 1s; Northern Pintail 4s; American Wigeon 4p; scoters 2; Hooded Merganser 7p,7s,13f; Common Loon 12p,10s,7f.
1988: Wood Duck 2p,4s,16f; Mallard 4p,6s,2f; Northern Pintail 2s; American Wigeon 3p; Common Eider 8f; scoters 6; Hooded Merganser 4p,9s; Bufflehead 1p; Common Loon 10p,7s.
1989: Wood Duck 12p,6s; Mallard 1p,6s; American Wigeon 1p,2s; scoters 17; Oldsquaw 7; Bufflehead 1p; Hooded Merganser 7p,3s,7f; Red-breasted Merganser 1s; Common Loon 11p,8s.

Nova Scotia

1986: Mallard 1p,2s; Gadwall(?) 1p; American Wigeon 9p; Common Eider 2p; scoter 26; Bufflehead 22; Brant 90; Common Loon 18p,25s.
1987: Wood Duck 2p; Mallard 4p; American Wigeon 7p,1s,13f; Common Eider 6p,2s; Common Loon 15p,11s.
1988: Wood Duck 1s; Mallard 2p,2s,2f; American Wigeon 7p,43f; Common Eider 3p,62f; Oldsquaw 6; Bufflehead 6; Common Loon 14p,17s.
1989: Mallard 2p,2s; American Wigeon 9p,1s; Hooded Merganser 5p,2s; Common Eider 12p,1s,80f; scoters 10; Brant 95; Common Loon 23p,14s.

Newfoundland

1986: Greater Scaup 1s; Red-breasted Merganser 3s,7f; Common Loon 15p,16s.
1987: Mallard 1p; Greater Scaup 1s; Red-breasted Merganser 1p; Common Loon 17p,7s.
1988: Mallard 2s; Red-breasted Merganser 1s; Common Loon 20p,14s.
1989: Mallard 1p,1s; Red-breasted Merganser 1s; Common Loon 15p,16s.